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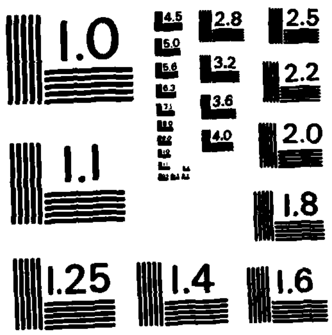
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FOREIGN TECHNOLOGY DIVISION

MEASUREMENT TECHNIQUES

(Selected Articles)

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THE DEVELOPMENT OF LITHIUM NIOBATE LASER POWER STABILIZER

Yuan Hai lin, Chu Hwai ju, Lao Liu, Liu Chen ming,
Hsu Lee and Sun Jen in
(Shanghai City Testing Institute) (Shanghai Silicate Institute)

At the present time, in order to improve the stability of laser power, many institutes in the country are using various means to stabilize laser power with great success. This paper introduced the lithium niobate crystal He-Ne laser power stabilizer developed in our work.

I. WORKING PRINCIPLE

The working principle of this laser power stabilizer is shown in Figure 1. The laser beam from the output of a He-Ne laser 1 after passing through a lithium niobate electric light switch 2 is split into two beams by the beam splitter 3. One beam is used as the light output and the other beam is used as the signal for the feedback circuit. It is sent into the photo-electric tube 4 and then passed through current-voltage converter 5, comparative amplifier 6 and differential amplifier 8 to control the flux of the photo-electric switch. When the power of the laser is increased, the power sampled by the beam splitter also increases to raise the output current signal of the photodiode. This current signal produces a rising voltage signal through the use of a current to voltage converter. The voltage difference, after comparing this signal with the base voltage 7 using the comparative amplifier, is amplified by the differential amplifier to generate a decreasing positive signal as the output. This signal is added to the ground of the differential circuit 8 to raise the output voltage of the collector of the differential circuit. From the control curve of the lithium niobate electric light controller under parallelly polarized light condition (as shown in Figure 2) we know that when the light intensity increases, it can be decreased by simply increasing the voltage. Hence, the light intensity after passing through the controller remains constant and vice versa. (The operating point is usually chosen at 50% light intensity and half wave voltage at 1/2).

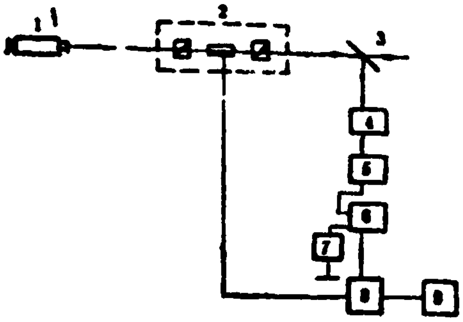

Figure 1. Principle of power stabilizer
1--He-Ne laser; 2--lithium niobate electric light switch; 3--beam splitter; 4--photo-electric tube; 5--current voltage converter; 6--comparative amplifier; 7--base voltage; 8--differential circuit; 9--high voltage

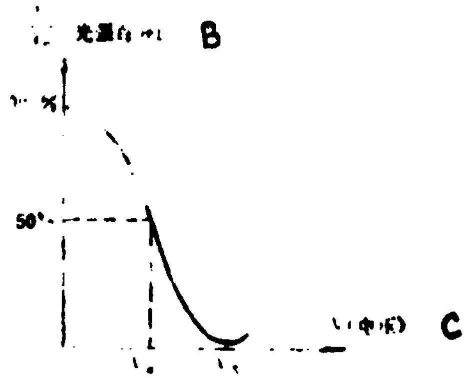

Figure 2. The control curve of lithium niobate electric light controller under parallelly polarized light
B--% of light intensity;
C--V(voltage)

II. STRUCTURE

(1) Optical system

In the optical system, each optical element had to match with the electric system. The key element was the lithium niobate electric light switch. For this element we had to consider the direction of cleavage, dimensions and method of preparation of the crystal, half wave voltage and light extinction ratio, uncertain loss, selection of the working point and deflection vibration element and its position in the optical path. The dark current of the photo-electric converter element had to be as low as possible.

1. Lithium niobate electric light switch

(1) The selection of direction of cleavage, preparation method and size of lithium niobate crystal

In the instrument we chose a lithium niobate electric light switch which was cut in the Z direction [1]. Light was passed in the Z-axis

and the electric field was in the x-axis. The crystal was prepared transversely. The He-Ne laser had an output of 40 milliwatt and 3 milliwatt. According to the actual light beam diameter, the crystal sizes were $X \times Y \times Z = 2\,mm \times 2\,mm \times 16\,mm$ and $X \times Y \times Z = 2.8mm \times 2.8mm \times 16mm$. The measured half wave voltage was 400-500 volts. In order to reduce the effect of ambient temperature fluctuation on the crystals, a piece of copper $10\,mm \times 15\,mm \times 30mm$ in size was used as the heat sink. The crystal was adhered to the heat sink by a conductive adhesive.

(2) Light extinction ratio

For the lithium niobate electric light switch, the requirement of the light extinction ratio was not very high. Based on experiment, the light extinction ratio should be over 100:1 to be satisfactory.

(3) The selection of working position for the light switch

In an ordinary electric light switch with light passing in the z-axis and electric field in the x-axis, the polarizer and the analyzer are perpendicular to each other and are parallel to the X and Y direction of the crystal, respectively. The light intensity passed at this time is

$$I_{\perp} = I_0 \sin^2\left(\frac{\pi}{\lambda} \cdot \Delta n \cdot l\right)$$

where l is the optical path of the crystal, Δn is the electrical double refractive index whose value is related to the electric field on the crystal. When the voltage is at the half wave voltage V_{π} $\Delta n \times l = \lambda/2$. At this time, $I_{\perp} = I_0$. The switch is completely open. However, because the working curve at this point is $f(x) = \sin^2 x$, and the variation of light intensity with the voltage is the smallest near the half wave voltage V_{π}, in order to optimize the working sensitivity and linearity, we have chosen a switch working point near $V_{\pi}/2$.

(4) The relationship between the polarizer and the analyzer

In order to satisfy the requirement of the electric circuit, we changed the perpendicularly polarized light to parallelly polarized

light. The light intensity passing through the light switch is

$$I_{11} = I_0 \cos^2(\pi/\lambda \cdot \Delta n \cdot l)$$

thus avoiding the addition of a phase reversal ci.cuit in the electrical circuit to simplify the circuit and to reduce the error. In order to increase the output light intensity, if the laser output is linearly polarized light, the polarizer can be eliminated from the electrical circuit. By adjusting the position of the laser and that of the analyzer, the direction of the linearly polarized light output from the laser can be made parallel to that of the analyzer. The analyzer is a prism whose dimensions are $8mm \times 8mm \times 16mm$.

(5) The position of the light switch in the optical path

Considering the effect of temperature fluctuation on the light switch, photo-change and the drift of the working point over long periods of time, we placed the sampling beam splitter behind the optical switch. Thus, the light intensity fluctuation due to the light switch could be sent into the feedback circuit to be controlled in order to improve the accuracy of stability of the power stabilizer.

2. <u>Photo-electric converting element</u>

In the optical path, we used the photo-electric diode produced by Shanghai Technical Physics Bureau. When a 6 volt bias was applied, the output current and the input light intensity had a very good linear relationship.

(2) Electrical circuit system

1. Current voltage converter. The photo-electric diode is a current output device. In order to obtain a good linear output, we must make its load near short circuit condition. Simultaneously, it is required to convert the current output of the photo-electric diode into voltage signals. We adopted an amplifier which was composed of operational amplifiers using opposite phase terminal input as shown in Figure 3. Considering the effective close loop gain and small drift of its class, the operational amplifier $F007_C$ was selected.

2. The comparative amplifier was composed of the operational amplifier $F007_c$. At the opposite phase terminal of the amplifier, the output signal V_{sr1} from the current-voltage converter was sent in as the input. The positive phase terminal is the base voltage V_{sr2}. As shown in Figure 4, in the expression $V_2 = -(V_{sr1} - V_{sr2})\frac{R_2}{R_1}$, the voltage V_2 can be calculated from V_{sr1} and V_{sr2}.

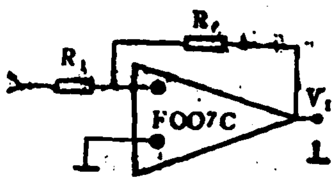

Figure 3. Current voltage converter

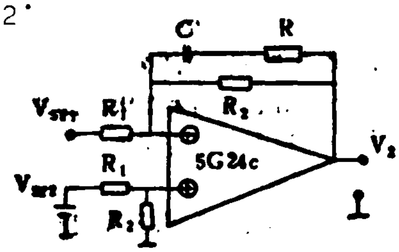

Figure 4. Comparative amplifier

3. Differential circuit. Because the working voltage of the differential circuit was 300 volts, the circuit was composed of a pair of high reverse voltage 3DA87E tubes as shown in Figure 5. Because of the feedback action of the resistor R_1, the error caused by the ambient temperature fluctuation was reduced. When the positive signal output from the comparative amplifier reached the ground of the 3DA87E tube, an appropriate high voltage output could be obtained from the collector grid of the 3DA87E tube to control the flux through the lithium niobate electric optical switch. In order to allow the electric optical switch to work in the sensitive region, the voltage chosen was $V_\pi/2$.

4. Base voltage. In this power stabilizer, the stability of the base voltage is directly affecting the accuracy of the result of the comparative amplifier and thus affecting the accuracy of the entire instrument. We adopted the high stability composite voltage stabilizing pile WB724HB and followed by the highly stable voltage stabilizing diode 2DW7C to stabilize the voltage. Through the sampling comparative amplifier, the stability of the voltage was further improved. The measured long term stability of this class of output was better than 0.01%. The electric circuit is shown in Figure 6.

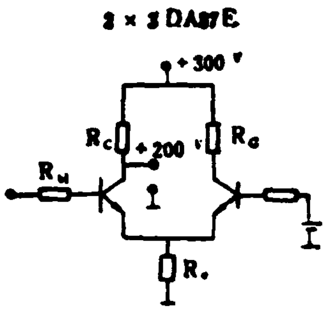

Figure 5. Differential circuit

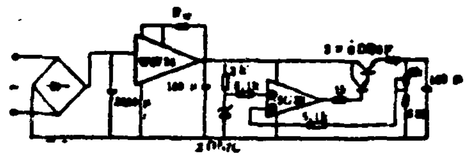

Figure 6. Base voltage source

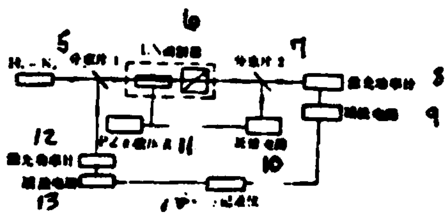

Figure 7. Schematic diagram of experimental apparatus
5--beam splitter; 6--controller; 7--beam splitter 2; 8--light source power meter; 9--subtraction circuit; 10--feedback circuit; 11--PZ8 digital meter; 12--laser power meter; 13--subtraction circuit; 14--x-y recorder

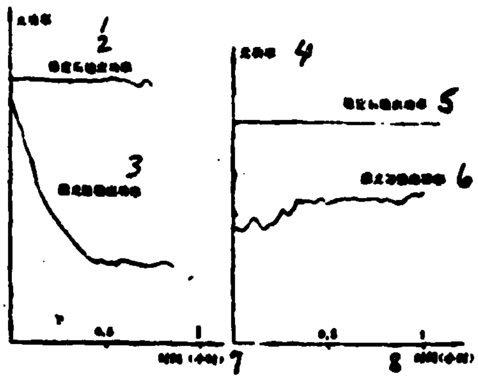

Figure 8. Experimental results
1,4--optical power; 2,5--stabilized power output; 3,6--laser power output; 7,8--time (hours)

5. High voltage source. For the high voltage source, the composite stable voltage pile W3724HB was adopted as the driving source and 2x3DD15 was used for current expansion and adjustment. Then, a comparative amplifier was used to further stabilize the voltage to improve the stability accuracy. Stable voltage was controlled into pulses using a pair of 3AD18 transistors and a pulse transformer. After a voltage rising transformer, rectifier and filter, we obtained a stable high voltage. The measured long term stability of this kind of voltage was better than 0.01%.

III. EXPERIMENTAL

In order to further improve the accuracy of the experiment, the original experimental apparatus was modified. The improved apparatus is as shown in Figure 7. The beam splitter 1 divided the laser beam output into two beams. The sampling beam was received by a model FP-1 optical fiber power meter. The variable was sent into the x-y recorder after passing through the subtraction circuit. The stabilized beam was received by a model FP-1 optical fiber power meter and recorded in an x-y recorder after passing through the subtraction circuit. Thus, the variation of the laser power and the stability accuracy of the stabilized laser beam could be obtained and compared on the curve. Simultaneously, a PZ8 digital meter was used to monitor the variation of the output from the power meter after the subtraction circuit and the values were marked on the corresponding curves.

In the experiment, we used the following equation to define the power stability of the laser:

$$n = \frac{\text{maximum power--minimum power}}{(\text{maximum power + minimum power})/2} \times 100\%$$

The experimental results are shown in Figure 8. Figure 8a showed that the stabilized power output variation was within 103% when the variation of the laser power was 103%. Figure 8b showed that the variation of the stabilized power output was within 0.2-0.3% when the laser tube power variation was at around 20%.

IV. ERROR ANALYSIS

(1) Optical portion

In the experiment, the working conditions of the lithium niobate electro-optical modulator are: half wave voltage 500 volts (0.6238 μm) equilibrium room temperature is 20°C at steady power working voltage is 250 volts, electrical phase difference 90°, output light intensity $I_{0p}=0.5I_0$. When the temperature variation is no less than 1°, as a result of calculation (calculation omitted) electrical phase difference variation is minute. Therefore, the

variation of light intensity caused by it is also negligible. Hence, the error due to the optical portion can be neglected.

(2) Electrical portion

1. The long term stabilities of base and high voltage sources (several hours) were measured to be better than .01% .

2. A stringent heat shield was adopted in the photo-electric diode in the optical path. The temperature variation in the laboratory was less than ±1°/8 hours. This error was less than 0.1%.

3. In the electric circuit, the stable operational amplifier $F007_c$ was adopted. Its uncalibrated voltage drift was 10 microvolt/degree. Because the output voltage of the I-V circuit was about 1 volt, therefore, the I-V circuit and comparative amplifier errors due to temperature variation could be neglected.

4. In the differential circuit, because a pair of 3DA87E tubes of the same parameters were used and because of the reaction of the feedback resistor R_1, the error due to a temperature variation of less than ± 1° could be considered negligible.

However, since the errors above are independent, the total error is

$$\Delta = \sqrt{(0.1\%)^2 + (0.01\%)^2 + (0.01\%)^2}$$
$$< 0.2\%$$

It shows that the error analysis agreed with the experimental results.

Experimental results indicated that when the fluctuation of the laser power is greater than 5%, the use of this can improve its stability by an order of magnitude. When the fluctuation is less than 5%, after stabilization, the stability can reach 0.2-0.3%/hour. The stability system has an uncertain loss of about 1/2 of the laser light output. The 3 milliwatt He-Ne laser produced by the Shanghai Glass Instrument Factory no. 1 and the 40 milliwatt He-Ne laser produced by

the Shanghai Laser Institute have a measured stability of less than 5%/hour.

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SOME PROBLEMS REGARDING THE MEASUREMENT OF LIGHT FREQUENCY

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I. INTRODUCTION

After 20 to 30 years of effort, the frequency measurement work has already established perfect theories and more accurate measuring techniques. Directions from now on should be:

1. to obtain a more stable and more reliable practical frequency source,
2. to extend the upper limit of frequency measurement from microwave to submillimeter wave and optical wave,
3. to study new measurement techniques, to find new frequency measuring equipment and to expand the applications of this technique in modern scientific technology.

These three areas complement each other. Not a single one can be left out. Among them, the improvement of the stability of the frequency source is the most important high priority task.

Frequency is the most accurately measured physical quantity in the natural world. The relation between energy and frequency is

$$E_2 - E_1 = h\nu$$

It makes frequency a very important parameter in the observation of the microscopic world. In 1947, Elamb discovered the "shift" between the energy levels $^2S_{1/2}$ and $^2P_{1/2}$ of hydrogen whose frequency is 1057.9 MHz (Elamb shift), and this caused the birth of quantum field theory. This unusual physical phenomenon inside a particle is the emphasis of present research. But there have not been many studies using accurate frequency measurements as the parameter. The measurement of light frequency can do the job in this area. In addition, light frequency measurement can also bring tremendous benefits to optical communication, optoelectrowave spectroscopy and many practical applications.

Using a laser as an optical frequency related electromagnetic radiation source has received a lot of attention in the scientific community. A lot of work has been done but its practicality has not been demonstrated. Using the theoretical and practical experience in the frequency measurement field in the study of lasers not only can perfect practical lasers earlier, but also will expand the research area of itself to enrich the content of experiments.

Hence, it is believed that the stabilization and measurement of optical frequency are new territories of frequency measurement science which is a insufficiently explored research field with lots of chances of success.

II. THE RELATIONSHIP BETWEEN RADIO FREQUENCY MEASUREMENT AND OPTICAL FREQUENCY MEASUREMENT

Radiowave and light waves are transverse electromagnetic waves with very good coherent relation between space and time. The laser beam has an excellent directional characteristic. However, radio frequency waves can also be made into very narrow beams after coherence treatment. Of course, due to the difference on the order of over 10 orders of magnitude in wavelength, the corresponding elements are significantly different. However, this does not affect its consistency in nature.

The accuracy of measurement of wavelengths of light waves is relatively low. But the accomplishments in wavelength measurement cannot be ignored. For example, the experiment which proved that "ether" does not exist in space in 1887 by Michelson and Morley demonstrated that the true difference which is phase difference would be distinguished as 10^{-15} sec and the relative accuracy could reach 10^{-3} order of magnitude. In the same year, Hertz had just discovered the electromagnetic wave. Therefore, in the development of optical frequency measurement, it is necessary to extract lots of information from optical technologies. The radio frequency measurement and optical frequency measurement will complement each other to further promote frequency measurement work.

1. Interferometer and phase comparison method: Optical interference technique is the basis of precision optical measurement. Phase comparison is a method with high accuracy in frequency measurement. The two are practically identical in principle. The only difference is the working frequency (see Figure 1). The accuracy of phase comparison is theoretically proportional to the working frequency. Through linear phase check and interpolation, very high accuracy can be reached. However, in the optical frequency, due to the fact that frequencies are extremely high, resolution is very high even without these processes. If they are adopted, then it is possible to attain a time resolution of 10^{-20} sec. From a historical point of view, the phase comparison method is a reappearance of optical interference in the low frequency segment.

2. The present frequency stability theory can be used as the theoretical basis and starting point of optical frequency stabilization and measurement. These theories include: exponential spectral noise model; time domain expression and measurement of stability, transformation from time domain expression into frequency domain expression, the effect of finite data on the measured results and the reliability of stability when considering the relevance of noise, etc. Using these theories, it is possible to accurately and reasonably describe the stability of optical frequency.

3. From the point of view of studying method and field, optical frequency and radio frequency measurements of frequency are complementary and supplement each other. Merely using the transformation between frequency domain and time domain as an example, the Warner-Sinchant equation is the expression of this principle:

spectrum density $$W(\omega)=\int_{-\infty}^{\infty} R(\tau)e^{-i\omega\tau}d\tau$$

relevant function $$R(\tau)=\frac{1}{2\pi}\int_{-\infty}^{\infty} W(\omega)e^{-i\omega\tau}d\omega$$

Using it, we certainly can perform transformation between time domain and frequency domain. However, we also wish to prove this

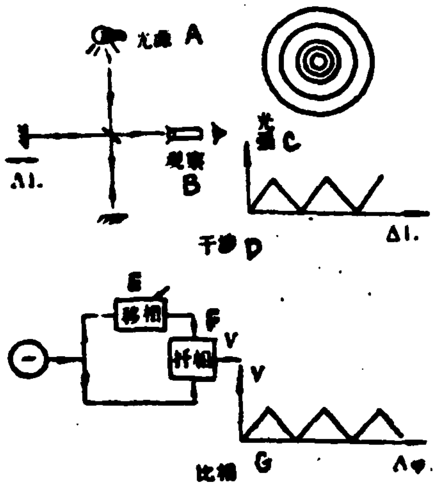

Figure 1. Interference and phase comparison
A--light source; B--observation; C--light intensity; D--interference; E--phase shift; F--phase interference; G--phase comparison

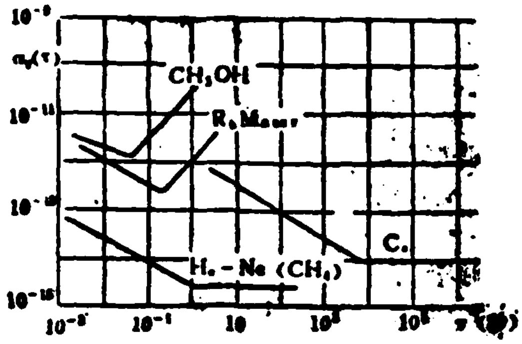

Figure 2. The $\sigma_y(\tau)$ vs. τ curve of two similar frequency targets

relation by actual measured quantities. In the radio frequency range, the measurement of spectrum density is more difficult. In the optical frequency region, due to the large variation in absolute frequency, it is easier to carry out measurement of spectrum density to facilitate this type of proof.

4. Some of the topics in optical frequency and radio frequency methods have very similar mechanisms. Hence, the experimental method, theoretical analysis and technical procedures can be used to mutually motivate the advancement. In the $\sigma_y(\tau)$ vs. τ curve, this similarity exists with special interest (see Figure 2).

As another example, the far infrared methanol (CH_3OH) laser excited by carbon dioxide is very similar to the rubidium quantum oscillator. The former was found to have a shifted Elamb dip [1]. This phenomenon may be helpful in the explanation of the mechanism of the optical frequency shift machine of optically pumped microwave transmitter (including absorption bubble type).

III. SEVERAL OPTICAL FREQUENCY STABILIZATION METHODS

At the present time, the first objective of optical frequency measurement is to obtain a laser signal source with a stabilized frequency. The laser is an electromagnetic oscillator which has the characteristics of extremely short wavelength and is easily affected by environmental factors such as mechanical vibration, shape change and temperature, etc. In addition, a slight change of the optical characteristics of the medium would cause the optical frequency to fluctuate. Therefore, the first mission of optical frequency stabilization is to stabilize with respect to these parameters. The following is an introduction of the loop frequency stabilization method which is the only way to obtain a highly stable frequency laser signal.

1. High precision frequency stabilization system: This kind of system, most of the time, wisely uses some quantum characteristics of the laser working material or absorbing material to stabilize the laser beam frequency. For example, the center of the gain curve of the laser working material, Elamb dip, anti-Elamb dip [2], etc., are such quantum characteristics. By choosing the proper quantum characteristics, very high stability can be achieved. The thought and method are very similar to those of an atomic frequency standard. A lot of work has begun and its theoretical basis can be considered as "saturated spectroscopy".

2. Low accuracy frequency stabilization methods: Power frequency stabilization method [5]: laser power and frequency have a fixed relation. When the power of the laser does not fluctuate along with other factors, the control of power can accomplish the purpose of stabilizing and adjusting frequency (shown in Figure 3). The final frequency stability is going to be determined by the stability of the laser power and the loop control characteristics. This type of system can obtain a laser signal which is relatively stable in frequency and accurately tunable. Coordinated with branch selection technique, it is possible to carry out optical frequency tuning in a relatively wide region.

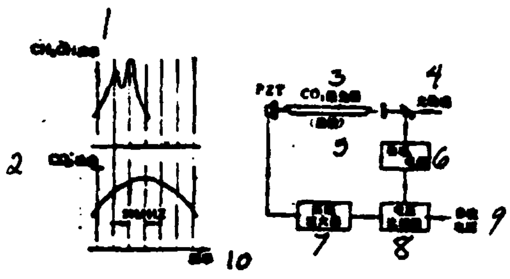

Figure 3. Power frequency stabilization method
1--CH_3OH power; 2--CO_2 power; 3--CO_2 laser; 4--light output; 5--(illegible); 6--power voltage; 7--high voltage amplifier; 8--voltage comparator; 9--reference voltage 10--(illegible)

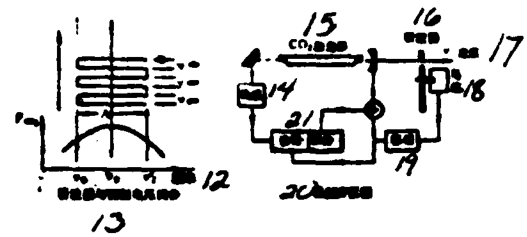

Figure 4. Modulation method
12--frequency; 13--synchronous laser and modulating voltage; 14--(illegible); 15--CO_2 laser; 16--wave chopper; 17--light beam; 18--motor; 19--phase shift; 20, 21--(illegible);

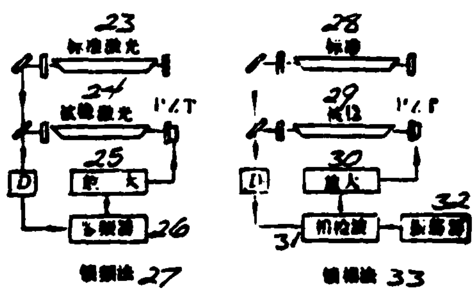

Figure 5. Frequency locking system
23--standard laser; 24--stabilized laser; 25--amplified; 26--frequency monitor; 27--frequency locking method; 28--standard; 29--to be stabilized; 30--amplified; 31--phase check wave; 32--oscillator; 33--phase locking method;

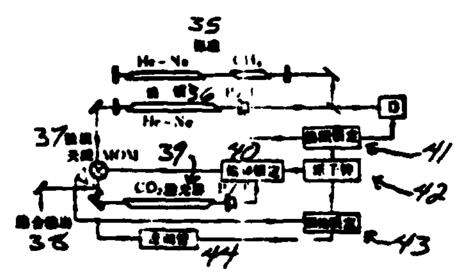

Figure 6. Optical frequency combination
35--standard; 36--lock; 37--microwave antenna; 38--combined output; 39--CO_2 laser; 40--frequency lock-in; 41--frequency lock-in; 42--atomic clock; 43--frequency lock-in; 44--velocity adjustment tube

Modulation method [4]: This is a very clever frequency stabilization method. A modulation signal is used to lock the center frequency of the laser at the center of the gain curve. However, the output power jumps between two fixed values because square pulse large modulation is used. By the proper choice of the width of the modulating pulse, together with the solution of the portion of beam needed using a light sample, a stable frequency laser beam output can be obtained. This same method can obtain a stable frequency and tunable laser beam but the output is pulsed light (see Figure 4).

Chamber length stabilization method [5]: Helium-neon gas laser has a relatively wide gain curve (about 1.5 giga Hz) within which two more laser oscillations may be produced simultaneously. The frequency difference between two neighboring oscillating modes is $\Delta f = C/2L$. when L is the harmonic oscillation chamber length. Therefore, through the stabilization of Δf, it is possible to stabilize the optical frequency. Of course, it is also possible to adjust the oscillating frequency of the laser by varying Δf.

3. Optical frequency combination technique: A simple frequency locking system is shown schematically in Figure 5. This is the frequency locking or phase locking loop of the laser [6]. The locked laser gains the stability of the standard laser and its output frequency can be adjusted in a certain range by a control system.

The frequency locking combination loop (see Figure 6) uses a stable frequency tunable laser to lock the optical chamber (interferometer) and then the latter is used as the standard to lock a laser with a frequency ν_1 . The value of ν_1 can vary in different wave segments: This system can obtain a 1 Hz linear width laser oscillation.

Frequency combination is a key technique in radiowave frequency measurements. It will have an important effect on optical frequency measurements and its applications. Hence, we must pay attention to it. Here, we must first solve the problem of expanding the frequency tuning range of the laser which is the development of tunable lasers.

4. Transformation from microwave to light (submicrometer wave): Using a submillimeter laser as the oscillating source to observe the higher order multiple frequency signals of a velocity adjustment tube or using the higher order harmonics of the velocity adjustment tube to study the characteristics of the oscillation of submillimeter lasers had been reported long ago. Here we introduce the use of an atomic clock as the multiple frequency key in a submillimeter laser which uses the long term stability of the atomic clock and also takes advantage of the superb short term stability of the HCN laser. This is a more reasonable method (see Figure 7).

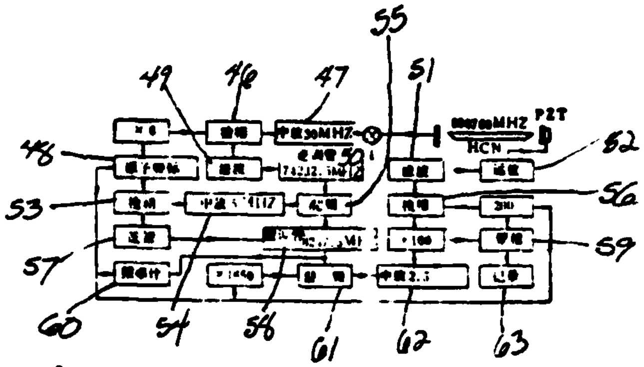

Figure 7. 890 MHz lock-in phase chain
46--phase check; 47--passing 30 MHz; 48--atomic frequency standard; 49--filter; 50--velocity adjustment tube; 51--filter; 52--operating; 53--phase check; 54--passing 5 MHz; 55--frequency mixing; 56--phase check; 57--low filter; 58--velocity adjustment tube; 59--phase lock in; 60--frequency counter; 61--frequency mixing; 62--passing 2.5; 63--recording

5. Other frequency stabilization methods: For example, the use of photo-acoustic effect to stabilize frequency, the use of Smith-Fox chamber [6] to stabilize frequency and power, etc.

The above methods demonstrate the multi-purpose nature of the stable working frequency of lasers. In general, for a specific problem there is always an optimal method. This cannot be replaced by light velocity measurements and corresponding study must be conducted.

IV. MEASUREMENT OF OPTICAL FREQUENCY

After obtaining tunable stable frequency signals, the measurement of optical frequency becomes simple. At this time the frequency of the signal source approaches the measured frequency with sufficient accuracy so that pitch difference can be obtained using photo-electric receivers (such as photomultipliers or cadmium mercury tellurode detectors, etc.). A spectrograph or frequency counter is used to perform the measurement. Non-linear elements with high speed effect are the keys to the measurement of optical frequency. Metal-oxide-metal (MOM) and metal-insulating layer-metal (MIM) diodes have special superior characteristics;the response speed can reach over 100 tera Hz. For any electromagnetic wave on them, a higher order non-linear effect is produced (see Figure 8) to obtain a pitch frequency . The general expression is

$$\nu_L = L\nu_1 + m\nu_1 + n\nu_{..} \pm \nu_B$$

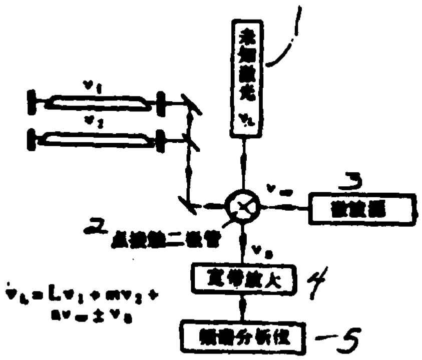

Figure 8. Frequency measurement unit
1--unknown laser V_L; 2--point contact diode;
3--microwave source; 4--band width amplification; 5--spectrograph

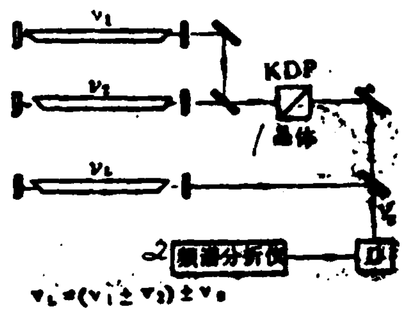

Figure 9. Non-linear crystal frequency measurement
1--crystal; 2--spectrograph

To determine the values of L, m, n is complicated. The light velocity value measurement chain is formed by basic frequency measurement element in series at different working frequencies. Presently, the number of basic elements needed for this measured quantity is drastically reduced.

When the wavelength is shorter, we can consider using an optically non-linear crystal to carry out frequency mixing (see Figure 9). It has a very high response speed. With the appearance of newer model high efficiency non-linear elements, the measurement of optical frequency work is becoming easier.

V. CLOSING REMARKS

To begin optical frequency measurement work is an absolute must. It is a new territory of frequency measurement. It not only can enrich and deepen the research content of this science but also can promote the improvement of the characteristics of the laser to accelerate its implementation. The determination of the speed of light can assist the measurement of optical frequency but cannot replace it. Light frequency combination technology is the key in optical frequency measurements. Here the stability, reliability and tunability of the laser become very significant problems. Optical frequency mixing and

optical receiver elements are very important prerequisites but in our country they are not looked upon seriously.

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